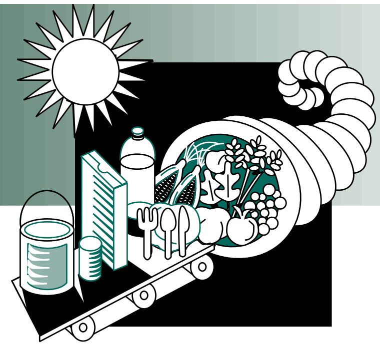
AGRICULTURE

Project Fact Sheet



Chemicals from Lignocellulose

Benefits

- Uses 90 percent less energy than conventional process
- Eliminates production of waste salt
- Produces a nontoxic, degradable solvent
- Lowers production costs of ethyl lactate
- Eliminates environmental impact of open burning of waste biomass
- Replaces more hazardous solvents
- Reduces greenhouse gases through assimilation of atmospheric CO_2 by plants
- Allows extensive recycling within the process
- Expands California's ethyl lactate market and use of regional crops
- Potential 2020 target market is 920 million pounds of lactate esters per year
- Projected 2020 fossil fuel displacement is 22.3 trillion Btu

Applications

The U.S. market for lactate esters and their derivatives is estimated to be 11.9 x 10^9 lb/year in 2020. Applications will include producing "green" solvents to replace those currently derived from petroleum feedstocks, as well as polymers and large-volume oxychemicals.

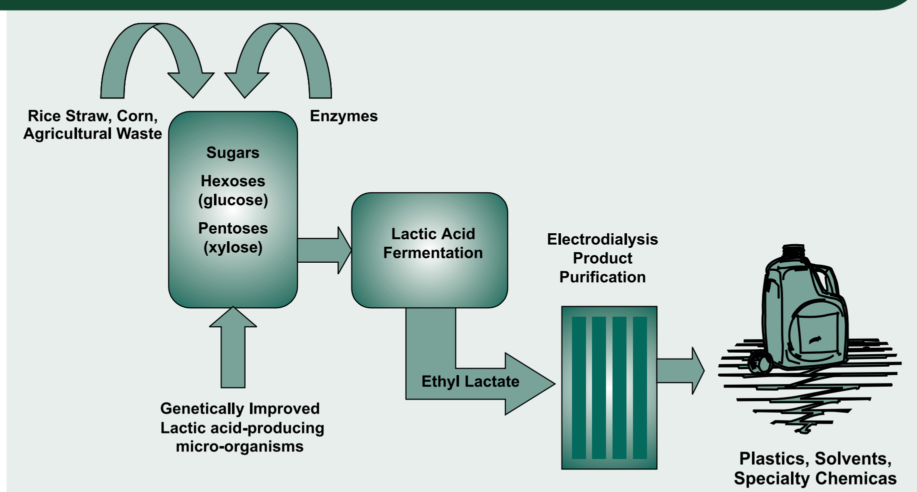
Biomass feedstocks will be used to produce a variety of chemical products

The fermentation of sugars derived from rice straw or other biomass, along with new advanced separations technology, offers the possibility to produce higher value added chemicals, such as lactate ester, ethyl lactate, and ethanol. Ethyl lactate is an excellent solvent that is nontoxic and degradable, with applications in both the industrial and consumer sectors.

With an innovative membrane-based technology developed by Argonne National Laboratory, ethyl lactate and other lactate esters can be produced at a lower cost using carbohydrates rather than petrochemicals as feedstocks. Energy requirements of the new technology are one-tenth those of the traditional process, and salt is eliminated as a processing waste. Ethyl lactate is also a versatile "building block" used to produce a variety of chemical products such as degradable plastic polymers, three-carbon oxygenated chemicals, and derivatives of specialty products. It is estimated that the potential U.S. market could exceed 7 billion lb/yr, worth $5 billion. The world market for the products could be twice as large.

The opportunity exists to integrate the production of lactate ester with the availability of low-cost agricultural waste. The California Institute of Food and Agricultural Research at the University of California, Davis is developing processing capabilities to convert the state's highly concentrated feedstock of lignocellulose biomass (e.g., rice straw) into inexpensive sugars. Although there are technical challenges to overcome, the project should result in significant energy savings and environmental and economic benefits for California's agricultural industry and the nation.

Process for Converting Rice Straw to Ethyl Lactate



Ethyl lactate produced from renewable resources can be used to make plastics and "green" solvents

Project Description

Goals: To use advanced separation technologies to increase the range of feedstocks that can be used in biorefinery systems and to engineer microbes that can handle simultaneous conversions of different kinds of sugars and simultaneous saccharification and fermentation processes.

The feedstocks will be evaluated as a source of inexpensive carbohydrate, and they will be adapted to the known requirements of the current lactate ester process. Two approaches will be undertaken: 1) identify feedstock mixtures that are most compatible with hexose fermentation to lactate esters and 2) develop fermentations capable of using both hexoses (e.g., glucose) and pentoses (e.g., xylose). Mixed sugars generated from the feedstocks will be exposed to various lactic acid-producing microorganisms. Productive strains will undergo genetic modification to allow use of both hexoses and pentoses. Strains of both wild type and genetically modified microbes will be examined for carrying out separate hydrolysis and fermentation, as well as simultaneous saccharification and fermentation. The fermentation process will be integrated with an effective product purification process, such as Argonne National Laboratory's electrodialysis-based process, to produce a good yield of high-purity lactate esters from the biomass.

Progress and Milestones

The following milestones will be accomplished:

- Characterization of selected biomass feedstocks.
- Pretreatment of selected biomass feedstocks with enzymes and cellulase-producing organisms.
- Development of methods for producing enzymes at a bench scale.
- Development of lactic acid-producing microorganisms.
- Development of a lactic acid fermentation process and scaling-up to 100 liters.
- Development of the purification and esterification process to obtain ethyl lactate.
- Production of 1 kilogram of purified ethyl lactate using an integrated biomass-to-ethyl lactate process.

Project Partners

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Davis, CA

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BC International Corporation
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California Energy Comission
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